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Assessment of the relationship between adoption of a knowledge-intensive water-saving technique and irrigation conditions in the Mekong Delta of Vietnam

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ABSTRACT

Alternate wetting and drying (AWD) is an irrigation technique developed to save water in paddy rice farming. We investigated how local paddy irrigation conditions affected the adoption of AWD by farmers in An Giang province of the Mekong River Delta region, Vietnam. To this end, we used community-level statistics collected in the dry seasons of 2009–2010, 2011–2012, 2013–2014, and 2014–2015. We focused on paddy elevation, density of channel networks, and degree of triple-cropping as indicators of irrigation conditions. We performed a partial rank order correlation coefficient analysis between AWD adoption rates and these irrigation conditions and several other related factors. Variations in irrigation conditions caused by paddy elevation and infrastructure status were identified as affecting AWD implementation. Although AWD is a knowledge-intensive practice for optimizing watering amounts and timing in paddy rice farming, and requires no extra infrastructure or machinery, it does require well-arranged irrigation conditions. Moreover, the significance of the channel network in AWD adoption was emphasized in a year with low rainfall, indicating that farmers prefer continuous flooding to AWD as a hedge against water shortages. In AWD, continuous flooding is considered a waste of water from the viewpoint of rice plant physiology; however, where irrigation conditions are less than ideal, continuous flooding includes the role of water reservoirs. Therefore, the prerequisite conditions for diffusion of AWD need to be reconsidered.

1. Introduction

As the global population continues to steadily increase, staple crop yields must also increase to meet the demand for food (FAO, 2011). Water is an essential resource for stable agricultural production, but as competition for water resources between domestic, industrial, and agricultural sectors increases, the agricultural sector must increase food production with limited water resources, and improving agricultural water productivity has become an urgent issue (Hundertmark and Facon, 2003). Paddy rice farming, in particular, requires more water than other staple crops such as wheat and maize because irrigated rice paddies are generally flooded from the transplantation (or sowing) stage to harvest (Tuong and Bouman, 2003). Thus, the establishment of water-saving techniques is particularly vital in rice farming.

The International Rice Research Institute (IRRI) has found that paddy rice only needs to be flooded during the rooting and flowering stages (Van der Hoek et al., 2001). Consequently, IRRI developed a rice-growing procedure called “Alternate Wetting and Drying” (AWD), whereby paddy fields are only intermittently irrigated outside of these critical stages. A “safe-AWD” procedure for this intermittent irrigation stage can be described as follows: (1) a perforated plastic pipe is set into the ground to precisely monitor the belowground water level; (2) farmers supply no more than 5 cm of water to their paddies and then do not irrigate again until the water level naturally declines to 10–15 cm below the soil surface; (3) this process is repeated several times after the rooting stage up until the flowering stage. When farmers follow this procedure, total water usage can be reduced by 10%–40% relative to continuous flooding with no significant negative impact on yield, improving agricultural water productivity (e.g. Lampayan et al., 2015). Hence, IRRI has attempted to spread the AWD practice in various Asian rice-growing regions (e.g., Sibayan et al., 2010).

In addition to saving water, AWD can also reduce farmers’ pumping costs and irrigation charges, thereby directly increasing their net income. Moreover, because AWD is a knowledge-intensive technique (e.g. Aakkula et al., 2005; Pingali et al., 1998) for optimizing irrigation amounts and timing in paddies based on an understanding of soil water

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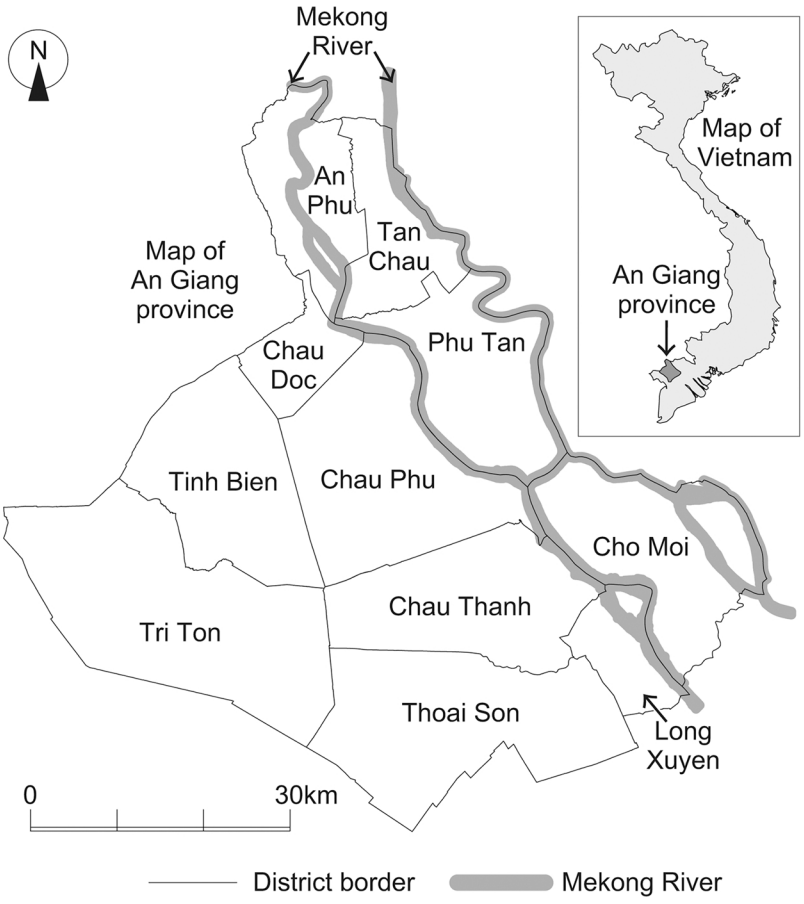

Fig. 1. Map of An Giang Province.

conditions by means of a simple instrument, it can be adopted by local farmers at low cost (Kurschner et al., 2010). Therefore, studies on AWD diffusion have emphasized how the proper understanding and practice of the technique are imparted to the farmers (Kurschner et al., 2010; Rejesus et al., 2013).

However, based on empirical studies in China, Li (2001) and Loeve et al. (2001) raised concerns that the successful implementation of AWD requires not only a proper understanding and practice of the technique but also reliable and flexible irrigation conditions. A similar situation was also shown in a qualitative study in the Mekong Delta of Vietnam (Yamaguchi et al., 2017), where farmers hesitated to adopt AWD in paddies that did not directly connect with water channels or were located at higher elevations, because such paddies tended to have unstable water conditions (Yamaguchi et al., 2017). Those studies indicated that farmers would be prepared to adopt AWD when they were confident that their irrigation conditions were reliable and timely enough to allow irrigation to be carried out according to schedule (Mushtaq et al., 2006), and conversely that AWD might not be easily accepted in areas that have suffered from water scarcity, despite the fact that AWD was developed as a water saving technique. Moreover, one of the AWD's merits is its low cost for farmers to implement; however, if implementation of AWD requires a considerable dependence on irrigation conditions, then factors other than just introductory costs must also be examined. These factors are likely to be of significant concern when considering AWD diffusion. However, the relationship between adoption of AWD and irrigation conditions has not been verified with quantitative data. Hence, this study aimed to investigate the linkage between AWD diffusion and water supply conditions by using quantitative data from the Mekong Delta, Vietnam.

The delta regions of South and Southeast Asian countries are good candidates for AWD implementation (Kurschner et al., 2010; Quynh and Sander, 2015). Delta basins such as the Mekong, Irrawaddy, Chao Phraya, and Bengal have long been primary rice production bases (Barker et al., 1985), supporting the growing Asian population. However, the current sea level rise due to global climate change has caused saline water intrusion into these regions, creating a shortage of water for rice farming (Wassmann et al., 2004; IBRD and World Bank, 2010; Driel and Nauta, 2013; Rahman and Bhattacharya, 2014). Moreover, groundwater overdraft and decreasing river flows have also contributed to deteriorating agricultural water conditions (MacDonald et al., 2015; Thilakarathne and Sridhar, 2017). AWD has the potential to alleviate the negative impacts of these issues on rice farming in these regions.

The Mekong Delta region accounts for more than half of the domestic rice production in Vietnam, which is a leading rice exporter. Nevertheless, for the reasons outlined above, it is increasingly difficult for rice farmers in this region to obtain the required amount of water. Therefore, water-saving technologies are particularly crucial for rice farming in this region.

The Mekong Delta is a wide floodplain; therefore, slight variations in elevation have a substantial impact on drainage, access to irrigation water, and susceptibility to flooding, and these factors significantly influence land cover and rice farm management in this region (Kaida, 1974; Thuy and Anh, 2015). We hypothesized that certain paddy elevations would hinder farmers' adoption of AWD by impeding water control. This study evaluates the irrigation conditions of the Mekong Delta rice farming according to "paddy elevation" and "water channel density".

Mekong Delta farmers have endured water shortages during the dry season. In response, channel networks have grown as rice farming has intensified (Kono, 2001). In the areas where channel networks are limited, farmers occasionally use plot-to-plot irrigation, which leads to difficulties in controlling paddy water (Yamaguchi et al., 2017).